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REMARKS/ARGUMENTS

Claims 1-26 are pending. Claim 9 was indicated to be drawn to patentable subject matter. Claims 1, 3, 4, 13-15, and 17-20 were rejected as anticipated by U.S. Patent No. 5,121,604 to Berger et al. Claims 1, 2, 4-8, 10-16, and 18-24 were rejected as anticipated by U.S. Patent No. 5,867,986 to Buratti et al.

Applicant appreciates the indication of allowable subject matter. However, for the reasons set forth below, it is respectfully submitted that all of the pending claims are patentable over the cited references.

The invention defined by independent Claims 1 and 17 relates to a control system and method, respectively, that address the objective of improving the speed of transient response of a turbocharger variable-geometry mechanism when operating conditions change. In accordance with the claimed invention, the control signal that is supplied to an actuator for the variable-geometry mechanism comprises either (1) a first value comprising a _pulse_ of predetermined amplitude and duration, or (2) a second value different from the first value. The first value or pulse is supplied when the difference {desired control value – a previous desired control value} is greater than a predetermined threshold; otherwise the second value is supplied.

The idea behind the claimed invention is that when operating conditions change rapidly such that a calculated new position for the variable-geometry mechanism differs by a relatively large amount (i.e., greater than the predetermined threshold) from the previously calculated position in a previous control iteration, transient response of the turbocharger can be improved by supplying a large-amplitude pulse of relatively short duration to the actuator, after which the control signal is switched to a "normal" control signal (i.e., the "second value" as claimed).

As an illustrative example, the specification in Figure 8 and accompanying text describes a comparison between a conventional control method and a control method in accordance with the invention, for a full-range displacement (fully closed to fully open) of variable turbine nozzle

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vancs in a turbocharger system. The initial pulse of the control signal results in a considerably improved transient response of the vane displacement compared to the conventional approach without any such pulse.

Berger

Berger discloses a control method and system for a turbocharged diesel engine, which has the objective of running the engine with an empirically determined optimum fuel consumption by controlling the charging pressure P_{Ld}. The charging pressure is controlled by controlling a turbine bypass valve 22, or alternatively by controlling a variable-geometry turbine (col. 2, lines 9-16). An electronic regulating device 40 controls the bypass valve or variable-geometry turbine (i.e., the controlled device) by supplying a control signal TV to a converter 28, which in turn supplies a vacuum signal through a line 36 to the controlled device. The regulating device 40 receives various inputs, including the measured or actual charging pressure P_{La}, which may differ from the optimum or desired charging pressure P_{Ld}. The desired charging pressure is empirically derived to provide minimum fuel consumption at any given engine power output ME_d and speed.

The control signal TV fed to the converter 28 is in the form of a pulse train of variable duty ratio, and the converter is operable to adjust the vacuum in the line 36 proportionally to the duty ratio of the pulse train (col. 2, lines 35-40).

The desired and actual charging pressure values P_{Ld} and P_{La} are supplied to a comparator 52 and the resulting error signal is fed to a proportional-integral (PI) control 54, which supplies an output signal TV_R to a limiter 56 and a summing junction 58.

Berger states that to improve dynamic response of the comparator 52 and PI control 54, a variable TV_K produced by a pre-control 60, and a variable TV_S from a memory 62 based on stored curves (Fig. 4) are also supplied to the summing junction. The sum of these signals is the control signal TV. (Col. 3, lines 28-39.)

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Applicant cannot find anything in Berger teaching or suggesting that the control signal TV for controlling the variable-geometry turbine should be supplied in the form of a pulse of predetermined amplitude and duration when the error signal is above a predetermined threshold, and otherwise should be supplied as a second value when the error signal is not above the predetermined threshold. The Office Action points to a number of passages in Berger that are said to teach this aspect of the claimed invention, but these passages have nothing to do with the claimed aspect. The passage at column 3, lines 15-35 describes the improvement in dynamic response through use of the pre-control 60 and memory 62 as already described above. This passage does not suggest supplying the control signal TV as a pulse of predetermined amplitude and duration only when the error signal is above a predetermined threshold. As previously noted, Berger does disclose the control signal TV as a pulse train, but that is completely different from the pulse of the claimed invention. Berger's pulse train is always supplied, regardless of the value of the error signal, and the duty ratio (see col. 3, lines 50-53 for a definition of duty ratio) is adjusted to regulate the converter 28. Furthermore, the use of the pulse train has nothing to do with improving transient response of the variable-geometry turbine.

The passage at column 1, lines 29-44, merely discusses the general concept of controlling the charging pressure based on a characteristic field, and has nothing to do with improving transient response of a variable-geometry turbine. The passage at column 2, line 22 through column 4, line 14, describes the overall architecture of the regulating device 40 as summarized above, but has no disclosure about improving transient response of a variable-geometry turbine by using a pulse of predetermined amplitude and duration as claimed.

For at least the above reasons, it is respectfully submitted that Berger does not teach or suggest a control system and method as claimed in independent Claims 1 and 17.

Independent Claim 16 is drawn to a control system having a logic circuit structured and arranged to produce a pulse control signal. Claim 16 further recites means for providing a desired control signal to a first input of the logic circuit, and means for providing a previous

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control signal to a second input of the logic circuit. Nowhere does Berger suggest any means for providing a previous control signal to a logic circuit.

Claim 16 also includes a controller structured and arranged to provide a normal control signal, and a switch receiving the normal control signal and the pulse control signal. The switch is responsive to the logic circuit output so as to provide the pulse control signal to the switch output responsive to a first value on the logic circuit output, and to provide the normal control signal to the switch output responsive to a second value on the logic circuit output. Whether the first value or the second value is on the logic circuit output depends on the value of the difference between the first and second inputs of the logic circuit (i.e., the difference between the desired control value and the previous control value).

Based on the previous explanation of Berger, it should be apparent that Berger does not teach or suggest a switch as required by Claim 16.

For these reasons, Claim 16 is respectfully submitted to be patentable over Berger.

Thus, all of the independent claims are clearly not taught or suggested by Berger.

Buratti

Buratti discloses a control system and method for controlling the supercharge pressure of a diesel engine by controlling a variable-geometry turbine of the turbocharger. As an initial matter, Buratti contains no disclosure relating to improving the speed of transient response of a turbocharger variable-geometry mechanism. Buratti instead is mainly concerned with reducing supercharge pressure overshoot during acceleration. Buratti recognizes that during acceleration, proportional-integral control (such as the type disclosed in Berger) is slow and acts on the variable blades of the turbine with a delay, which results in the supercharge pressure overshooting the desired value and subsequently settling at the desired value accompanied by oscillations (col. 2, lines 24-33). To address this problem, Buratti employs a control method wherein an acceleration output signal or control signal is formed as a linear combination of (1) a

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pressure signal related to the actual supercharge pressure PSmis, (2) a reference signal related to the desired supercharge pressure PSrif, and (3) a correction signal related to a time derivative of the pressure signal, DPS.

More specifically, Buratti employs a control unit 20 that has a proportional-derivative (PD) control group 21 and a proportional-integral (PI) control group 22. The PD control group 21 generates an error signal Err equal to PSrif minus PSmis, and then forms a proportional signal U_1 equal to a constant Kp_1 times Err. The PD control group also generates the time derivative of the actual supercharge pressure, DPS, and forms a derivative signal U_2 equal to a constant Kd times DPS. The output of the PD control group, DutyV1, is equal to $U_1 + U_3 - U_2$, where U_3 is an initiating signal that is a constant value for defining a reference position of the variable turbine nozzle blades 8 in the absence of proportional and derivative signals U_1 and U_2. (Col. 3, lines 25-61, and Fig. 3.)

The PI control group 22 forms a PI output signal DutyV2 based on the error signal Err = PSrif − PSmis. The control unit 20 also includes a selection device 32 that decides, based on the value of PSmis, to use either the PD output DutyV1 or the PI output DutyV2, as the control signal DutyV. The selection device 32 makes this decision using the algorithm shown in Fig. 4. The objective of the algorithm is to reduce the amount by which the actual supercharge pressure PSmis overshoots the desired value PSrif during a rapid acceleration, and to reduce the oscillations in the supercharge pressure once the desired pressure is reached. Fig. 5 shows the reduction in overshoot and oscillations in the actual supercharge pressure P_1 using the method of Fig. 4, compared to the pressure P_2 obtained when only PI control is used. It will be noted that Buratti's method does not result in increased speed of transient response of the supercharge pressure.

The method of Fig. 4 entails starting out using PI control, by selection of the PI output signal DutyV2 during the initial phase of an acceleration (see block 35 in Fig. 4). However, as soon as the derivative DPS (equal to d(PSmis)/dt) becomes greater than a threshold value (block 37) indicating a rapid increase in supercharge pressure, control is switched to PD control (block

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38) so that the control signal is equal to DutyV1. The control is switched back to PI control (block 40) when the derivative DPS becomes equal to or less than zero (indicating that supercharge pressure has stopped increasing), or that the elapsed time t since the threshold value of DPS was crossed is greater than a predetermined maximum value Tmax. (Col. 4, lines 20-47.)

Nowhere in Buratti's disclosure is there any mention or suggestion of providing a control signal as a pulse of predetermined amplitude and duration. Nowhere is there any mention or suggestion of forming a first difference parameter as the difference between a desired control value and a previous desired control value in a previous sample period. Nowhere is there any mention or suggestion of providing the control signal as a pulse of predetermined amplitude and duration when the first difference parameter is greater than a predetermined first threshold, and otherwise providing the control signal as a second value when the first difference parameter is not greater than the first threshold.

The passages of Buratti pointed out in the Office Action do not teach or suggest these aspects of the claimed invention. Figure 3 and the accompanying description merely describe the mixed PI and PD control scheme as explained above. Figure 4 and its description merely describe the algorithm for switching between PI and PD control.

Thus, with respect to independent Claims 1 and 17, apparently Buratti fails to teach or suggest improving the speed of transient response of a turbocharger variable-geometry mechanism when operating conditions change, by supplying a control signal to an actuator for the variable-geometry mechanism comprising either (1) a first value comprising a pulse of predetermined amplitude and duration, or (2) a second value different from the first value, wherein the first value or pulse is supplied when the difference {desired control value – a previous desired control value} is greater than a predetermined threshold, and otherwise the second value is supplied.

With respect to independent Claim 16, apparently Buratti fails to teach or suggest a controller structured and arranged to provide a normal control signal, and a switch receiving the normal control signal and the pulse control signal, wherein the switch is responsive to the logic

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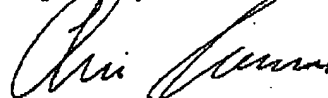Filed: June 24, 2003
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circuit output so as to provide the pulse control signal to the switch output responsive to a first value on the logic circuit output, and to provide the normal control signal to the switch output responsive to a second value on the logic circuit output, depending on the value of the difference between the first and second inputs of the logic circuit (i.e., the difference between the desired control value and the previous control value). As should be apparent from the foregoing discussion of Buratti, neither the PD control output DutyV1 nor the PI control output DutyV2 is a pulse control signal.

For these reasons, it is respectfully submitted that the present claims are patentable over Buratti.

Conclusion

Based on the above amendments and remarks, it is submitted that the application is in condition for allowance. The Examiner is invited to telephone the undersigned if there are any remaining issues requiring resolution before a Notice of Allowance can be issued.

Respectfully submitted,

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Faisal Adnan